

Patent No. 2979522

Registration Date: September 17, 1999

Issue Date: November 15, 1999

Application No.: 6-30275

5 Application Date: February 28, 1994

Laid-open No.: 7-240536

Laid-open Date: September 12, 1995

Request for Examination Filing Date: December 5, 1995

Appeal No. 10-6062

10 Appeal Filing Date: April 16, 1996

Patentee

Kabushiki Kaisha Shimazu Seisakusho

Inventor

15 Satoshi Akita

References

Patent Application Laid-Open No. 4-163968 (JP, A)

Utility Model Application Laid-Open No. 5-91619 (JP, U)

Utility Model Application Laid-Open No. 58-61423 (JP, U)

20

BEST AVAILABLE COPY

[Title of the Invention] LIGHT SOURCE DEVICE FOR CURING
PHOTOPOLYMERIZATION RESIN

[Claims]

[Claim 1] A light source device for curing a
5 photopolymelization resin comprising: a plurality of light
emitting diodes having peak emission wavelength in a range of
430 to 480 nm; an optical system means for converging lights
of the light emitting diodes; and a light irradiating means
for outputting the light converged by the optical system means.

10 [Detailed Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention relates to a light source device
for curing a photopolymelization resin to be used as dental
15 material.

[0002]

[Prior Art]

In the recent years, a photopolymelization resin adapted
to be polymerized by a visible light has been rapidly spreading
20 as dental material, such as for dentistry storage, repair and
so forth. The photopolymelization resin is prepared by
blending a photosensitizing agent in a monomer. The
photosensitizing agent is decomposed by absorbing light
irradiated. This initiates polymerizing reaction of the
25 monomer. Such photopolymelization resin is advantageous for
capability of varying a polymerizing reaction speed and a curing
depth according to the irradiation intensity of the light. As

dental material, for example, as photosensitizing agent, α -diketones such as camphor quinone (CQ) is used, and as monomer, multifunctional methacrylates, such as methyl methacrylate and so forth is used. Camphor quinone absorbs
5 light of wavelength of 410 to 500 nm, and particularly has high absorbing characteristics for the light of the wavelength of 430 to 480 nm.

[0003]

As a light source for curing such resin, a halogen lamp
10 is typically employed. Since an output light of the halogen lamp contains lights of various wavelengths, lights of wavelengths close to 410 to 500 nm, in which camphor quinone has high absorbing ability, are selected by an optical filter to irradiate on the photopolymerization resin. Fig. 4 shows
15 spectra of light irradiated from the conventional light source device and an absorptive wavelength band of camphor quinone. Since spectra A to D of the conventional light source device constructed with a combination of halogen lamp and optical filter is offset from absorptive wavelength band of camphor
20 quinone toward long wavelength side, the light source does not effectively function for curing of camphor quinone.

[0004]

As apparent from the above, the conventional light source device taking halogen lamp as light source encounters the
25 following drawbacks.

[0005]

- 1) A ratio of light in a wavelength range effective for

curing the photopolymelization resin is low. In order to overcome the lacking of polymerization and of curing depth of the photopolymelization resin, overall light intensity has to be made large a strong light having a high intensity of 500
5 to 1000 mW/cm² in the irradiation opening is required so that a problem in viewpoint of safety encounters.

[0006]

On the other hand, even when the device having high light intensity is employed, it can still be insufficient as light
10 intensity required for curing the photopolymelization resin. For sufficiently curing the resin, the irradiation opening has to be placed quite close to affected part to inherently cause stain or breakage of the irradiation opening.

[0007]

15 On the other hand, light emission of halogen lamp generates strong heat, so that a cooling by a cooling fan is required. Further when a concave mirror is employed as an optical system means for converging the light, the concave mirror can be easily clouded to be frequently maintained.

20 [0008]

2) The light source and the concave mirror may cause fatigue; the user is required to constantly monitor the light amount for adjusting irradiation period.

[0009]

25 3) As set forth, in order to obtain high light intensity, the power source becomes bulky, the cooling device has to be provided and so forth, which encounter drawback of increasing

size and weight of the device.

[0010]

[Problem to be Solved by the Invention]

The present invention has been worked out for solving
5 the foregoing problem. It is an object to provide a light
source for curing a photopolymelization resin which can enhance
polymerizing efficiency of the photopolymelization resin,
avoid influence of heat to be safe, does not cause fatigue of
the light source, and is compact and superior operation ability.

10 [0011]

[Means for Solving the Problem]

The present invention comprises a plurality of light
emitting diodes having peak emission wavelength in a range of
430 to 480 nm; an optical system means for converging lights
15 of the light emitting diodes; and a light irradiating means
for outputting the light converged by the optical system means.

[0012]

[Function]

The lights output from the light emitting diodes are
20 converged to a light irradiation head through the optical system
means. This light is discharged from the irradiating opening
at the other end of the light irradiating head via the light
irradiating head. Then, the output light is irradiated on the
photopolymelization resin applied to the affected part to
25 polymerize the photopolymelization resin.

[0013]

[Embodiment]

(First Embodiment) Fig. 1 is a block diagram showing a general construction of the first embodiment of a light source device for curing a photopolymelization resin according to the present invention. The reference numeral 1 denotes a power source, 2 denotes resistors, 3 denote LEDs (light emitting diodes), 3a denote LED chips forming the LEDs, 4 denotes optical fibers, 5 denotes a light irradiating head formed by bundling one ends of the optical fibers, and 5a denotes an irradiating opening.
[0014]

10 Next, discussion will be given for operation of the light source device for curing the photopolymelization resin of Fig. 1. The LEDs 3 applied bias voltage from the power source 1 through the resistors 3 emit light from the LED chips 3a. The LEDs 3 have peak emission wavelengths in a range of 430 to 480
15 nm. In the shown embodiment, twenty LEDs having peak emission wavelength of 455 nm and light output of 1200 μ W are used. Discharge lights enter to one ends of optical fibers 4 directly connected to or placed in the vicinity of the LED chips 3a and propagate to the other ends of the optical fibers 4 through
20 the optical fibers 4. Lights passing through the optical fibers 4 are converged by the optical irradiation head 5 which is formed by bundling the other ends of a plurality of optical fibers 4 and bound by a resin, and discharged from the irradiation opening 5a of the light irradiating head 5 as the
25 discharge light. The discharge light thus taken out is irradiated on the photopolymelization resin applied and filled in the affected part to cure the resin.

[0015]

Next, discussion will be given for curing of the photopolymelization resin in the shown embodiment. Fig. 4 shows spectra of light irradiated from the light source device of the present invention and an absorptive wavelength band of camphor quinone. As shown in Fig. 4, large part of the spectra E of the output light of the light source device for curing the photopolymelization resin of the shown embodiment is within the wavelength range of 430 to 480 nm effective for absorption by camphor quinone.

[0016]

Accordingly, such output light is irradiated on the photopolymelization resin, the photopolymelization resin can be polymerized satisfactorily by light output in the extent of one several tenth of the conventional light source.

[0017]

Particularly, in the shown embodiment, the light incident surface of light converging fibers can be arranged in contact with or quite close to the light emitting element of the LED chip to enhance converging efficiency and make the power higher.

[0018]

(Second Embodiment) Fig. 2 is a block diagram showing a general construction of the second embodiment of the light source device for curing the photopolymelization resin according to the present invention. In the drawings, 5' denotes a light irradiating head, 5'a denotes an incident opening, 5'b is an

irradiating opening, 6 denotes a convergence lens and 1 to 3 denote the same parts shown in Fig. 1.

[0019]

Next, discussion will be given for operation of the light source device for curing the photopolymelization resin of Fig. 2. Similarly to Fig. 1, twenty LEDs 3 having the peak emission wavelength in a range of 430 to 480 nm, in particularly 455 nm, twenty and having light output of 1200 μ W are arranged on the same circle. These discharge lights are converged by the convergence lens 6 and are projected on the surface of the incident opening 5'a of the light irradiating head 5' arranged in parallel on an optical axis of the convergence lens 6. The light irradiating head 5' of this embodiment is formed by bundling a plurality of optical fibers of substantially equal lengths and bound by the resin. However, the light irradiating head may be formed by a hollow pipe of metal or resin provided at inner surface thereof circle aluminum coating for total reflection of the LED lights or by a glass rod per se.

20 [0020]

The light converged by the light irradiating head 5' is taken out as discharge light from the irradiating opening 5'b through the light irradiating head 5'. The discharge light thus taken out is irradiated on the photopolymelization resin applied and filled in the affected party to cure the resin.

[0021]

It should be noted that concerning the curing of the

photopolymelization resin in this embodiment, the discussion will be eliminated as being similar to the first embodiment.

[0022]

(Third Embodiment) Fig. 3 is a block diagram showing a general
5 construction of the third embodiment of the light source device for curing the photopolymelization resin according to the present invention, which is an embodiment employing a concave mirror 7 as an output light converging system of respective LEDs.

10 [0023]

In this embodiment, the LEDs are same as those used in the first and second embodiments. The discharge lights from respective LEDs are reflected by the concave mirror 7 and converged to the surface of the incident opening 5'a of the
15 light irradiating head 5'. Respective LEDs 3 are arranged so that the discharge lights are converged by the concave mirror 7 toward the center of the incident opening 5a' of the light irradiating head 5' arranged in parallel on the optical axis of the concave mirror 7. The light irradiating head 5' is
20 formed by binding a plurality of optical fibers in substantially equal length by resin. However, similarly to the foregoing, the optical irradiating head may be constructed with the hollow pipe of metal or resin, or glass rod.

[0024]

25 It should be noted that curing of the photopolymelization resin in this embodiment is similar to that in the first embodiment. Thus, discussion will be eliminated.

[0025]

Particularly, in this embodiment, since the LEDs having the discharge light wavelengths which are almost within 430 to 480 nm which are absorptive wavelengths of camphor quinone are employed, the resin can be cured with the light of minimum intensity. Conventionally, for curing the resin by halogen light source, intensity of the overall light source is made large to pull up the intensity of the light of the absorptive wavelength band of camphor quinone. At the same time, the light intensity of the wavelength band unnecessary for curing the resin is also pulled up. Then, heat generation by the discharge light containing such unnecessary light causes clouding of the concave mirror. However, this problem can be solved by the present invention.

15 [0026]

On the other hand, the present invention includes the following embodiments.

[0027]

(1) Per each LED, the convergence lens is arranged on the front surface of the LED chip light emitting element for converging light discharged from the LED.

[0028]

(2) As optical system means, instead of using the optical fiber, convergence lens and so forth, with the hollow pipe reducing internal diameter toward the irradiating opening, with aluminum coating on the inner surface thereof for total reflection of the LED light, may be used for converging the

light emitted from the LEDs.

[0029]

(3) By placing the lens on the irradiating opening of the light irradiating head, the discharge light may be collimated.

5 At this time, it becomes unnecessary to place the irradiating opening in the vicinity of the affected part.

[0030]

[Effect of the Invention]

The light source device for curing the
10 photopolymelization resin according to the present invention
employs a plurality of LEDs as light emitting source and selects
the wavelength of the discharged light within the wavelength
range of 430 to 480 nm which is a absorptive wavelength band
of camphor quinone, thereby permitting a sufficient
15 polymerization of the photopolymelization resin with the light
of smaller intensity than that in the prior art. By this, the
power source can be made compact. On the other hand, since
sufficient light intensity can be obtained, the irradiating
opening is not required to be placed close to the affected part.
20 Further, by collimating the discharge light by placing the lens
on the irradiating opening of the light irradiating head, the
irradiating opening can be placed away from the affected part
to reduce stain and breakage of the irradiating opening. Since
heat is not generated, the light source device can be safe and
25 the cooling fan becomes unnecessary. Furthermore, clouding of
the concave mirror as the converging optical system means of
the third embodiment can be reduced.

[0031]

The light emitting diode as the light source hardly fatigue, is not necessary to adjust per use, and permits continuous use for long period.

5 [0032]

As described above, the power source can be small and the cooling fan becomes unnecessary to permit the overall device to be compact.

[Brief Description of the Drawing]

10 [Fig. 1]

A block diagram showing a general construction of one embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which optical fibers are used as converging optical system;

15 [Fig. 2]

A block diagram showing a general construction of another embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which convergence lens are used as converging optical system;

20 [Fig. 3]

A block diagram showing a general construction of the a further embodiment of a light source device for curing a photopolymelization resin according to the present invention, in which a concave mirror is used as converging optical system;

25 and

[Fig. 4]

An illustration showing a relationship of spectra of

light obtained by the conventional light source device, a spectra of light obtained by the light source device of the embodiment of the present invention, and an absorptive wavelength band of camphor quinone.

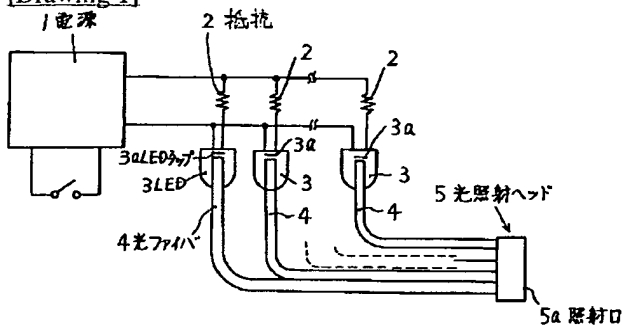
* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

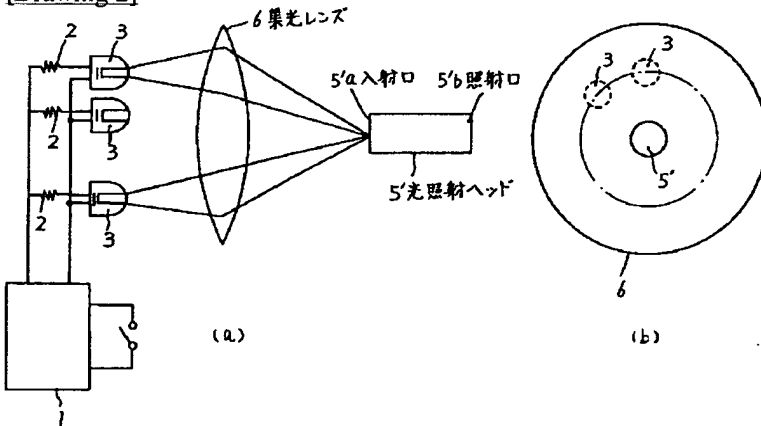
- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DRAWINGS

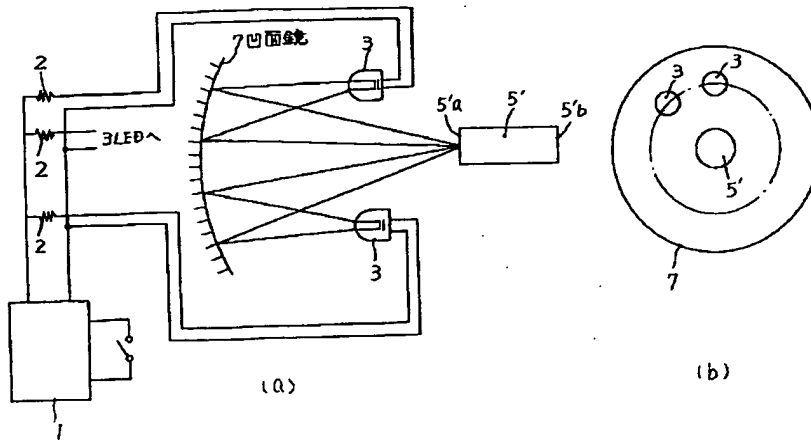
[Drawing 1]



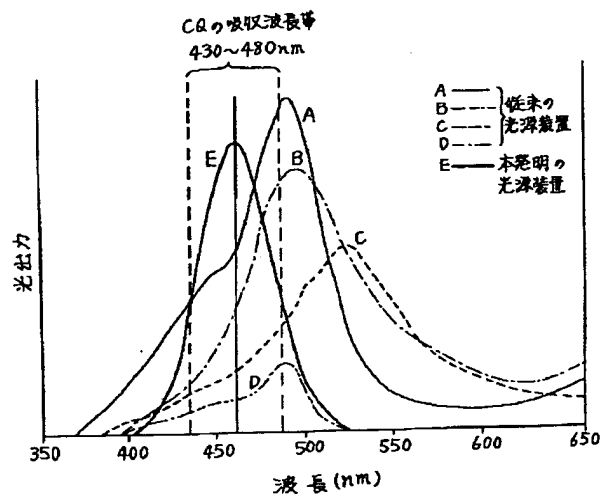
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]

*** NOTICES ***

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] Light equipment for photopolymerized type resin hardening characterized by constituting by two or more light emitting diodes in the domain whose peak emission wavelength is 430-480nm, optical-system means to condense the light of these light emitting diodes, and optical irradiation means to output the light condensed with this optical-system means.

[Translation done.]

[Patent number]	2979522
[Date of registration]	17.09.1999
[Number of appeal against examiner's decision of rejection]	10-06062
[Date of requesting appeal against examiner's decision of rejection]	16.04.1998
[Date of extinction of right]	

Copyright (C); 1998,2000 Japan Patent Office

*** NOTICES ***

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention relates to the light equipment for stiffening the photopolymerized type resin used as dental material.

[0002]

[Description of the Prior Art] Recently, the photopolymerized type resin which carries out a polymerization by the visible ray as dental material for a dentistry store repair etc. has spread quickly. As for photopolymerized type resin, the photosensitizer was blended into the monomer, when optical irradiation of the photosensitizer is carried out, light is absorbed, it decomposes and this makes the polymerization reaction of a monomer start. Such photopolymerized type resin has the advantage of the grade which can change a polymerization reaction rate and a case depth with the irradiation intensity of light. As dental material, as for a photosensitizer, alpha-diketones, such as a camphor quinone (CQ), are used, and, as for the monomer, polyfunctional methacrylate, such as methyl methacrylate, is used, for example. Although a camphor quinone absorbs light with a wavelength of 410-500nm, it has a sharp absorption property to 430-480nm wavelength light especially.

[0003] Generally as light source for stiffening such resin, the halogen lamp is used. Since the light of various wavelength is contained, the output light of a halogen lamp chooses light with a wavelength [which a camphor quinone absorbs well] of 410-about 500nm with a light filter, and it constitutes it so that photopolymerized type resin may be irradiated. the spectrum of the light irradiated from conventional light equipment by drawing 4 -- a spectrum and the absorption wavelength band of a camphor quinone are shown the spectrum of the conventional light equipment which consists of the combination of a halogen lamp and a light filter -- spectrums A-D -- the absorption wavelength band of a camphor quinone -- a long wave -- since it has shifted to the merit side, it turns out that this light source is not functioning effective in hardening of a camphor quinone

[0004] The conventional light equipment which uses a halogen lamp as the light source had the following faults so that it might understand also above.

[0005] 1) in order the rate of the light of a wavelength domain effective in hardening of photopolymerized type resin is low and to solve the shortage of a polymerization and the shortage of a case depth of photopolymerized type resin -- the luminous intensity as whole -- large -- it is necessary to carry out -- near the irradiation opening -- setting -- 500-1000mW/cm2 ** -- a strong light to say had to be treated and the big problem was in the safety aspect

[0006] Moreover, even if it used the large equipment of such luminous intensity, as luminous intensity required for hardening of photopolymerized type resin, it may be inadequate, and in order to fully harden resin, the irradiation opening had to be made to approach to very near the affected part, and it was surely accompanied by the dirt of the irradiation opening, or the crash.

[0007] Moreover, since it was accompanied by strong generation of heat, photogenesis of a halogen lamp needed cooling by the cooling fan. Moreover, as an optical-system means for condensing light, when a concave mirror was used, it needed to maintain frequently by this concave mirror tending to

become cloudy.

[0008] 2) Moreover, since the light source and a concave mirror deteriorated, always, the user needed to do the monitor of the quantity of light, and needed to adjust irradiation time.

[0009] 3) as mentioned above, in order to obtain strong luminous intensity, power needs to large-sized-ize or it is necessary to prepare a cooling system -- etc. -- there was a fault which equipment forms into a large-sized weight

[0010]

[Problem(s) to be Solved by the Invention] It was originated in order that this invention might solve the above-mentioned trouble, and the influence by heat is eliminated, and the purpose is safe and is offering the light equipment for photopolymerization type resin hardening without a light source degradation which was compact and was excellent in operability while it raises the polymerization luminous efficacy of photopolymerized type resin.

[0011]

[Means for Solving the Problem] this invention is characterized by establishing the light emitting diode in the domain whose peak emission wavelength is 430-480nm, an optical-system means to condense the light of the concerned light emitting diode, and an optical irradiation means to output the light condensed with the concerned optical-system means.

[0012]

[Function] The light outputted from light emitting diode is condensed by the optical irradiation head by the optical-system means. This light passes through an optical irradiation head, and an outgoing radiation is carried out from the irradiation opening which is the other end of the concerned optical irradiation head. And when the photopolymerized type resin which the concerned output light applied to the affected part irradiates, photopolymerized type resin carries out a polymerization.

[0013]

[Example]

(The 1st example) The optical irradiation head and 5a which are constituted by view 1 being the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 1st example of this invention, Light Emitting Diode chip with which power and 2 constitute resistance and Light Emitting Diode (light emitting diode) and 3a constitute [1] Light Emitting Diode in 3, and 4 bundling an optical fiber, and 5 bundling the end of an optical fiber are the irradiation opening.

[0014] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 1 is explained. Each Light Emitting Diode3 to which bias voltage was impressed through resistance 2 from power 1 emits light from Light Emitting Diode chip 3a. In the domain whose peak emission wavelength is 430-480nm, especially this example, Light Emitting Diode3 is a 455nm thing, and used 20 things whose optical outputs are 1200microW. After carrying out incidence of this outgoing-radiation light to a direct file or the end of an optical fiber 4 which approached at Light Emitting Diode chip 3a, it passes along the inside of this optical fiber 4, and progresses to the other end of an optical fiber 4. The other end of two or more optical fibers 4 is bundled, it is condensed by the optical irradiation head 5 hardened by the resin, and the light which has advanced the inside of an optical fiber 4 is taken out from irradiation opening 5a of the optical irradiation head 5 as outgoing-radiation light. Thus, when the taken-out outgoing-radiation light is irradiated by the photopolymerized type resin which carried out application restoration at the affected part, this resin hardens.

[0015] Next, hardening of the photopolymerization resin in this example is described. the spectrum of light with which drawing 4 is irradiated from the light equipment of this invention -- a spectrum and the absorption wavelength band of a camphor quinone are shown it is shown in drawing 4 -- as -- the spectrum of the output light of the light equipment for photopolymerized type resin hardening of this example -- the great portion of spectrum E is contained in the wavelength domain effective in absorption of a camphor quinone of 430-480nm

[0016] Therefore, if such output light is irradiated at photopolymerized type resin, the polymerization of the photopolymerized type resin can fully be carried out by 1/about some dozens optical output of the

conventional light source.

[0017] especially -- this example -- the optical plane of incidence of the fiber for condensing -- the light emitting device of Light Emitting Diode chip -- contact -- or it approaches extremely, and since it can arrange, condensing luminous efficacy becomes good and power can also be made high

[0018] (The 2nd example) View 2 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 2nd example of this invention, for 5', an optical irradiation head and 5'a of the incidence opening and 5'b are [the irradiation opening and 6] condenser lenses among drawing, and 1-3 show the same parts as drawing 1.

[0019] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 2 is explained. Light Emitting Diode3 has arranged 20 pieces for the domain whose peak emission wavelength is 430-480nm, and the thing whose optical output it is especially 455nm and is 1200microW on the same periphery as well as drawing 1. these -- an outgoing radiation -- light -- a condenser lens -- six -- condensing -- having -- a condenser lens -- six -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- projecting -- having . optical irradiation head 5' of this example -- abbreviation -- although two or more optical fibers of the same length were bundled and being considered as the briquette by the resin, it is a metal or the hollow pipe of a resin, and you may constitute from the thing and the glass rod itself which carried out aluminum coating so that Light Emitting Diode light might carry out total reflection of the wall

[0020] And the light condensed by optical irradiation head 5' is taken out from the irradiation opening 5'b as outgoing-radiation light through this optical irradiation head 5'. Thus, when the photopolymerized type resin which carried out application restoration irradiates at the affected part, this resin hardens the taken-out outgoing-radiation light.

[0021] In addition, about hardening of the photopolymerized type resin in this example, since it is the same as that of the 1st example, the explanation is omitted.

[0022] (The 3rd example) View 3 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 3rd example of this invention, and it is the example using the concave mirror 7 as an output light condensing system of each Light Emitting Diode.

[0023] Also in this example, Light Emitting Diode used the same thing as the 1st and the 2nd example. each -- Light Emitting Diode -- **** -- an outgoing radiation -- light -- a concave mirror -- seven -- reflecting -- having -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- condensing -- having -- although -- each -- Light Emitting Diode -- three -- an outgoing radiation -- light -- a concave mirror -- seven -- a concave mirror -- seven -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening moreover, optical irradiation head 5' -- the 2nd example -- the same -- abbreviation -- although two or more optical fibers of the same length were made into the briquette by the resin -- the above -- the same -- a metal or the hollow pipe made from a resin -- or you may constitute from a glass rod etc.

[0024] In addition, about hardening of the photopolymerized type resin in this example, it is the same as that of the 1st example, and an explanation is omitted.

[0025] Especially, at this example, since most outgoing-radiation light wave length uses Light Emitting Diode which is 430-480nm of the absorption wavelength band of a camphor quinone, resin can be stiffened by the minimum luminous intensity. Although generation of heat by the outgoing-radiation light to which it will also pull up the luminous intensity of an unnecessary wavelength band to hardening of resin, and contains such an unnecessary light in it simultaneously although the intensity as the whole light source was enlarged and the luminous intensity of the absorption wavelength band of a camphor quinone was pulled up by it in order to stiffen resin with the halogen light source conventionally caused the cloudy weather of a concave mirror, this trouble is cancelable with this invention.

[0026] By the way, the following examples are also included as an embodiment of this invention.

[0027] (1) In each Light Emitting Diode unit, a condenser lens may be arranged in the front face of Light Emitting Diode chip light emitting device, and the light which emits light from this Light Emitting

Diode may be condensed.

[0028] (2) You may condense the light which carried out aluminum coding and which emits light from Light Emitting Diode in the hollow pipe in which a bore becomes small so that Light Emitting Diode light may carry out total reflection of the wall as the irradiation opening is approached instead of using an optical fiber, a condenser lens, etc. as an optical-system means.

[0029] (3) A lens may be put on the irradiation opening of an optical irradiation head, and you may collimate outgoing-radiation light. It is not necessary to make the irradiation opening approach the affected part at this time.

[0030]

[Effect of the Invention] Since two or more Light Emitting Diodes were used for the light equipment for photopolymerized type resin hardening of this invention as the source of photogenesis and it selected outgoing-radiation light wave length in the wavelength domain of 430-480nm which is the absorption wavelength band of a camphor quinone, it can fully carry out the polymerization of the photopolymerized type resin with the light of an intensity smaller than the former as whole. Power can be miniaturized by this. Moreover, since sufficient luminous intensity is obtained, by it not being necessary to make the irradiation opening approach extremely to the affected part and, putting a lens on the irradiation opening of an optical irradiation head, and collimating outgoing-radiation light, the irradiation opening can be further separated from the affected part, and the dirt of the irradiation opening and a crash decrease. Moreover, since heat does not occur, it is safe, a cooling fan becomes unnecessary, and the cloudy weather of the concave mirror which is the condensing optical-system means of the 3rd example further decreases.

[0031] Moreover, the light emitting diode which is the light source has very few degradations, there is no need for the adjustment for every use, and the prolonged continuous duty of it becomes possible.

[0032] Moreover, since power can be miniaturized and a cooling fan also becomes unnecessary as mentioned above, miniaturization of the whole equipment can be attained.

[Translation done.]

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-240536

(43)Date of publication of application : 12.09.1995

(51)Int.Cl.

H01L 33/00
A61C 13/15

(21)Application number : 06-030275

(71)Applicant : SHIMADZU CORP

(22)Date of filing : 28.02.1994

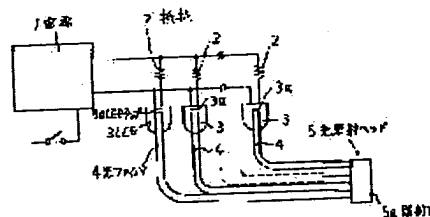
(72)Inventor : AKITA TOMOHITO

(54) PHOTOPOLYMERIZATION-TYPE RESIN SETTING OPTICAL SOURCE DEVICE

(57)Abstract:

PURPOSE: To provide a light source which is safe, restrained from deteriorating in intensity, free from thermal troubles, lightweight, compact in structure, and used for curing photopolymerization-type resin well.

CONSTITUTION: LEDs(light emitting diode) 3 which emit light rays of peak wavelengths 430 to 380nm and optical fibers 4 which serve as optical means which condense light rays emitted from the LEDs 3 and whose ends are bound up into a light irradiating head 5 are provided, and light rays emitted from the light irradiating head 5 are made to irradiate photopolymerization-type resin.



LEGAL STATUS

[Date of request for examination] 05.12.1995

[Date of sending the examiner's decision of rejection] 17.03.1998

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

*** NOTICES ***

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is one example of this invention shows the example using the optical fiber as condensing optical system.

[Drawing 2] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is other examples of this invention shows the example using the condenser lens as condensing optical system.

[Drawing 3] The block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is other examples of this invention shows the example using the concave mirror as condensing optical system.

[Drawing 4] the spectrum of the light obtained with conventional light equipment -- the spectrum of the light obtained with a spectrum and the light equipment of this invention example -- it is drawing showing the relation between a spectrum and the absorption wavelength band of a camphor quinone

[Translation done.]

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平7-240536

(43) 公開日 平成7年(1995)9月12日

(51) Int. Cl. ⁵	識別記号	庁内整理番号	P I	技術表示箇所
H 0 1 L 33/00	M			
A 6 1 C 13/15		7108-4C	A 6 1 C 13/ 14	B

審査請求 未請求 請求項の数 1 O L (全 5 頁)

(21) 出願番号 特願平6-30275

(22) 出願日 平成6年(1994)2月23日

(71) 出願人 000001983

株式会社島津製作所

京都府京都市中京区西ノ京桑原町1番地

(72) 発明者 秋田 智史

京都市中京区西ノ京桑原町1番地 株式会

社島津製作所三条工場内

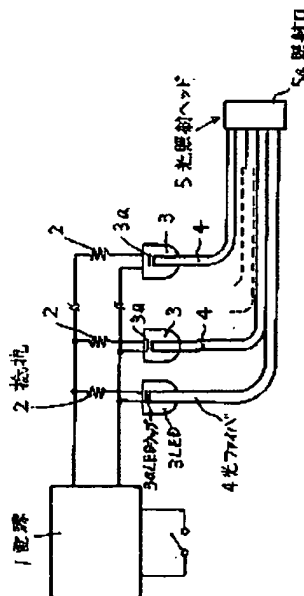
(74) 代理人 弁理士 西岡 義明

(54) 【発明の名称】 光重合型レジン硬化用光源装置

(57) 【要約】

【目的】 光重合型レジンの重合が充分となり、安全で、光源の劣化がなく、熱的問題がなく、軽くてコンパクトな光重合型レジン硬化用の光源を提供する。

【構成】 ピーク発光波長が430～480nmの範囲である光を発光する複数のLED（発光ダイオード）3と、当該LED3より発光された光を集光する光学系手段であって、一端を束ねられ光照射ヘッド5を形成する光ファイバ4とを設け、前記光照射ヘッド5から出力された光が、光重合型レジンに照射される。



(2)

特開平7-240536

1

2

【特許請求の範囲】

【請求項1】 ピーク発光波長が430～480nmの範囲にある複数の発光ダイオードと、これら発光ダイオードの光を集光する光学系手段と、この光学系手段で集光された光を出力する光照射手段とによって構成したことを特徴とする光重合型レジン硬化用光源装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、歯科材料として用いられる光重合型レジン硬化させるための光源装置に関する。

【0002】

【従来の技術】最近、歯科保存修復等の歯科材料として可視光線で重合する光重合型レジンが急速に普及している。光重合型レジンとは、モノマー中に光増感剤が配合されたもので、光増感剤は光照射されると光を吸収して分解し、これがモノマーの重合反応を開始させる。このような光重合型レジンとは、光の照射強度により重合反応速度および硬化深度を変えることができる等の利点を有する。歯科材料としては、例えば光増感剤はカンファークイノン（CQ）等の α -ジケトン類、モノマーはメチルメタクリレート等の多官能メタクリレート類が用いられている。カンファークイノンは、410～500nmの波長の光を吸収するが、特に430～480nmの波長光に対して鋭い吸収特性を持っている。

【0003】このようなレジン硬化させるための光源としては、一般にハロゲンランプが用いられている。ハロゲンランプの出力光は、いろいろな波長の光が含まれているため、カンファークイノンがよく吸収する410～500nmに近い波長の光を、光学フィルタで選択して、光重合型レジンに照射するように構成している。図4に、従来の光源装置から照射される光の分光スペクトルと、カンファークイノンの吸収波長帯とを示す。ハロゲンランプと光学フィルタとの組合せから構成される従来の光源装置の分光スペクトルA～Dが、カンファークイノンの吸収波長帯よりも長波長側にずれているため、この光源はカンファークイノンの硬化に有効に機能していないことがわかる。

【0004】以上でもわかるように、ハロゲンランプを光源とする従来の光源装置は、以下の欠点があった。

【0005】1) 光重合型レジン硬化に有効な波長範囲の光の割合が低く、光重合型レジン重合不足および硬化深度不足を解決するためには、全体としての光の強度を大きくする必要があり、照射口付近において500～1000mW/cm²という強い光を扱わなければならない。安全面に大きな問題があった。

【0006】また、このような光の強度の大きい装置を使用しても、光重合型レジン硬化に必要な光の強度としては不十分な場合があり、レジンに十分に硬化するためには、照射口を患部のごく近くまで接近させなければ

ならず、どうしても照射口の汚れや破損を伴った。

【0007】また、ハロゲンランプの発光は強い発熱を伴うため、冷却ファンによる冷却を必要とした。また、光を集光するための光学系手段として、凹面鏡を使用した場合、この凹面鏡がくもりやすく、メンテナンスを頻繁に行う必要があった。

【0008】2) また、光源及び凹面鏡が劣化するため、常に使用者が光量をモニタして照射時間を調整する必要があった。

【0009】3) 上述したように、強い光の強度を得るために、電源が大型化したり冷却装置を設ける必要があるなど、装置が大型重畳化する欠点があった。

【0010】

【発明が解決しようとする課題】本発明は、上記の問題点を解決するために創案されたもので、その目的は、光重合型レジン重合効率を高めるとともに、熱による影響を排除し安全で、光源劣化のない、コンパクトで操作性に優れた光重合型レジン硬化用光源装置を提供することである。

【0011】

【課題を解決するための手段】本発明は、ピーク発光波長が430～480nmの範囲にある発光ダイオードと、当該発光ダイオードの光を集光する光学系手段と、当該光学系手段で集光された光を出力する光照射手段とを設けたことを特徴とする。

【0012】

【作用】発光ダイオードから出力された光は、光学系手段によって光照射ヘッドに集光される。この光は、光照射ヘッドを経て、当該光照射ヘッドの他端である照射口から出射される。そして、当該出力光が患部に塗布した光重合型レジンに照射されることにより、光重合型レジンが重合する。

【0013】

【実施例】

（第1実施例）図1は、本発明の第1実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、1は電源、2は抵抗、3はLED（発光ダイオード）、3aはLEDを構成するLEDチップ、4は光ファイバ、5は光ファイバの一端を束ねて構成される光照射ヘッド、5aは照射口である。

【0014】次に、図1の光重合型レジン硬化用光源装置の動作を説明する。電源1から、抵抗2を介してバイアス電圧を印加された各LED3は、LEDチップ3aから光を発する。LED3は、ピーク発光波長が430～480nmの範囲、特に本実施例では455nmのもので、光出力が1200 μ Wのものを20個使用した。この出射光は、LEDチップ3aに直接接しもしくは近接された光ファイバ4の一端に入射した後、この光ファイバ4内を運って、光ファイバ4の他端へ進む。光ファイバ4内を進行してきた光は、複数の光ファイバ4の他

(3)

特開平7-240536

3

端が束われ、樹脂で固められた光照射ヘッド5により集光されて、光照射ヘッド5の照射口5aから、出射光として取り出される。このようにして取り出された出射光が、患部に塗布充填した光重合型レジンに照射されることによって、このレジンが硬化する。

【0015】次に、本実施例における光重合型レジンの硬化について述べる。図4は、本発明の光源装置から照射される光の分光スペクトルと、カンファークソンの吸収波長帯とを示す。図4に示すように、本実施例の光重合型レジン硬化用光源装置の出力光の分光スペクトルEの大部分は、カンファークソンの吸収に有効な波長範囲430~480nmに含まれる。

【0016】したがって、このような出力光を光重合型レジンに照射すると、従来の光源の数十分の1程度の光出力で、充分に光重合型レジンを重合させることができる。

【0017】特に、本実施例では集光用ファイバの光入射面をLEDチップの発光素子に当接又はきわめて近接して配置できるので、集光効率がよくなり、パワーも高くなる。

【0018】(第2実施例) 図2は、本発明の第2実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、図中、5'は光照射ヘッド、5'aは入射口、5'bは照射口、6は集光レンズで、1~3は図1と同一部品を示す。

【0019】次に、図2の光重合型レジン硬化用光源装置の動作を説明する。LED3は、図1と同じく、ピーク発光波長が430~480nmの範囲、特に455nmのもので、光出力が1200mWのものを、同一円周上に20個を配置した。これらの出射光は、集光レンズ6によって集光され、集光レンズ6の光軸上に平行に配された光照射ヘッド5'の入射口5'aの面に投射される。この例の光照射ヘッド5'は、略同一の長さの複数の光ファイバを束ねて樹脂で固めたものとしたが、金属もしくは樹脂の中空パイプで、内壁をLED光が全反射するようにアルミコーティングしたものやガラス棒自体で構成したものであってもよい。

【0020】そして、光照射ヘッド5'に集光された光は、この光照射ヘッド5'を通過してその照射口5'bから、出射光として取り出される。このようにして取り出された出射光は、患部に塗布充填した光重合型レジンに照射されることによって、このレジンが硬化する。

【0021】なお、本実施例における光重合型レジンの硬化については、第1実施例と同様であるのでその説明を省略する。

【0022】(第3実施例) 図3は、本発明の第3実施例である光重合型レジン硬化用光源装置の概略構成を示すブロック図で、各LEDの出力光集光系として凹面鏡7を用いた例である。

【0023】本実施例においても、LEDは第1、第2

4

実施例と同一のものを使用した。各LEDからの出射光は、凹面鏡7で反射され光照射ヘッド5'の入射口5'aの面に集光されるが、各LED3は、出射光が凹面鏡7により、凹面鏡7の光軸上に平行に配された光照射ヘッド5'の入射口5'aの中心に集光されるように配置される。また、光照射ヘッド5'は、第2実施例と同様に、略同一の長さの複数の光ファイバを樹脂で固めたものとしたが、前記同様に、金属もしくは樹脂製の中空パイプまたはガラス棒などで構成してもよい。

【0024】なお、本実施例における光重合型レジンの硬化については、第1実施例と同様であり、説明を省略する。

【0025】特に、本実施例では、出射光波長の大部分がカンファークソンの吸収波長帯の430~480nmであるLEDを使用するので、最小限の光の強度でレジン硬化させることができる。従来、ハロゲン光源でレジン硬化させるためには、光源全体としての強度を大きくし、それによってカンファークソンの吸収波長帯の光の強度を引き上げていたが、それが同時にレジンの硬化に不要な波長帯の光の強度をも引き上げることとなり、そのような不要な光を含む出射光による発熱が凹面鏡のくもりを引き起こしたが、本発明によりこの問題を解消することができる。

【0026】ところで、本発明の実施態様としては、以下のような実施例も含まれる。

【0027】(1) 各LED単位で、LEDチップ発光素子の前面に集光レンズを配置して、このLEDから発光する光を集光してもよい。

【0028】(2) 光学系手段として、光ファイバ、集光レンズ等を使用する代わりに、照射口に近づくにつれて内径が小さくなる中空パイプで、内壁をLED光が全反射するようなアルミコーティングしたもので、LEDから発光する光を集光してもよい。

【0029】(3) 光照射ヘッドの照射口にレンズを置いて、出射光をコリメートしてもよい。このとき、照射口を患部に近接させなくてもよい。

【0030】

【発明の効果】本発明の光重合型レジン硬化用光源装置は、その発光源として複数のLEDを採用し且つ出射光波長を、カンファークソンの吸収波長帯である430~480nmの波長範囲に選定したので、全体としては、従来より小さな強度の光で光重合型レジンを充分に重合させることができる。これによって、電源を小型化することができる。また、充分な光の強度が得られるので、照射口を患部まできわめて接近させなくてもよく、また光照射ヘッドの照射口にレンズを置いて出射光をコリメートすることで、さらに照射口を患部から離すことができ、照射口の汚れや破損が低減する。また、熱が発生しないので、安全で、冷却ファンが不要となり、さらに第3実施例の集光光学系手段である凹面鏡のくもりが低減

*** NOTICES ***

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention relates to the light equipment for stiffening the photopolymerized type resin used as dental material.

[0002]

[Description of the Prior Art] Recently, the photopolymerized type resin which carries out a polymerization by the visible ray as dental material for a dentistry store repair etc. has spread quickly. As for photopolymerized type resin, the photosensitizer was blended into the monomer, when optical irradiation of the photosensitizer is carried out, light is absorbed, it decomposes and this makes the polymerization reaction of a monomer start. Such photopolymerized type resin has the advantage of the grade which can change a polymerization reaction rate and a case depth with the irradiation intensity of light. As dental material, as for a photosensitizer, alpha-diketones, such as a camphor quinone (CQ), are used, and, as for the monomer, polyfunctional methacrylate, such as methyl methacrylate, is used, for example. Although a camphor quinone absorbs light with a wavelength of 410-500nm, it has a sharp absorption property to 430-480nm wavelength light especially.

[0003] Generally as light source for stiffening such resin, the halogen lamp is used. Since the light of various wavelength is contained, the output light of a halogen lamp chooses light with a wavelength [which a camphor quinone absorbs well] of 410-about 500nm with a light filter, and it constitutes it so that photopolymerized type resin may be irradiated. the spectrum of the light irradiated from conventional light equipment by drawing 4 -- a spectrum and the absorption wavelength band of a camphor quinone are shown the spectrum of the conventional light equipment which consists of the combination of a halogen lamp and a light filter -- spectrums A-D -- the absorption wavelength band of a camphor quinone -- a long wave -- since it has shifted to the merit side, it turns out that this light source is not functioning effective in hardening of a camphor quinone

[0004] The conventional light equipment which uses a halogen lamp as the light source had the following faults so that it might understand also above.

[0005] 1) in order the rate of the light of a wavelength domain effective in hardening of photopolymerized type resin is low and to solve the shortage of a polymerization and the shortage of a case depth of photopolymerized type resin -- the luminous intensity as whole -- large -- it is necessary to carry out -- near the irradiation opening -- setting -- 500-1000mW/cm2 ** -- a strong light to say had to be treated and the big problem was in the safety aspect

[0006] Moreover, even if it used the large equipment of such luminous intensity, as luminous intensity required for hardening of photopolymerized type resin, it may be inadequate, and in order to fully harden resin, the irradiation opening had to be made to approach to very near the affected part, and it was surely accompanied by the dirt of the irradiation opening, or the crash.

[0007] Moreover, since it was accompanied by strong generation of heat, photogenesis of a halogen lamp needed cooling by the cooling fan. Moreover, as an optical-system means for condensing light, when a concave mirror was used, it needed to maintain frequently by this concave mirror tending to become cloudy.

[0008] 2) Moreover, since the light source and a concave mirror deteriorated, always, the user needed to do the monitor of the quantity of light, and needed to adjust irradiation time.

[0009] 3) as mentioned above, in order to obtain strong luminous intensity, power needs to large-sized-ize or it is necessary to prepare a cooling system -- etc. -- there was a fault which equipment forms into a large-sized weight

[0010]

[Problem(s) to be Solved by the Invention] It was originated in order that this invention might solve the above-mentioned trouble, and the influence by heat is eliminated, and the purpose is safe and is offering the light equipment for photopolymerization type resin hardening without a light source degradation which was compact and was excellent in operability while it raises the polymerization luminous efficacy of photopolymerized type resin.

[0011]

[Means for Solving the Problem] this invention is characterized by establishing the light emitting diode in the domain whose peak emission wavelength is 430-480nm, an optical-system means to condense the light of the concerned light emitting diode, and an optical irradiation means to output the light condensed with the concerned optical-system means.

[0012]

[Function] The light outputted from light emitting diode is condensed by the optical irradiation head by the optical-system means. This light passes through an optical irradiation head, and an outgoing radiation is carried out from the irradiation opening which is the other end of the concerned optical irradiation head. And when the photopolymerized type resin which the concerned output light applied to the affected part irradiates, photopolymerized type resin carries out a polymerization.

[0013]

[Example]

(The 1st example) The optical irradiation head and 5a which are constituted by view 1 being the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 1st example of this invention, Light Emitting Diode chip with which power and 2 constitute resistance and Light Emitting Diode (light emitting diode) and 3a constitute [1] Light Emitting Diode in 3, and 4 bundling an optical fiber, and 5 bundling the end of an optical fiber are the irradiation opening.

[0014] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 1 is explained. Each Light Emitting

Diode3 to which bias voltage was impressed through resistance 2 from power 1 emits light from Light Emitting Diode chip 3a. In the domain whose peak emission wavelength is 430-480nm, especially this example, Light Emitting Diode3 is a 455nm thing, and used 20 things whose optical outputs are 1200microW. After carrying out incidence of this outgoing-radiation light to a direct file or the end of an optical fiber 4 which approached at Light Emitting Diode chip 3a, it passes along the inside of this optical fiber 4, and progresses to the other end of an optical fiber 4. The other end of two or more optical fibers 4 is bundled, it is condensed by the optical irradiation head 5 hardened by the resin, and the light which has advanced the inside of an optical fiber 4 is taken out from irradiation opening 5a of the optical irradiation head 5 as outgoing-radiation light. Thus, when the taken-out outgoing-radiation light is irradiated by the photopolymerized type resin which carried out application restoration at the affected part, this resin hardens.

[0015] Next, hardening of the photopolymerization resin in this example is described. the spectrum of light with which drawing 4 is irradiated from the light equipment of this invention -- a spectrum and the absorption wavelength band of a camphor quinone are shown it is shown in drawing 4 -- as -- the spectrum of the output light of the light equipment for photopolymerized type resin hardening of this example -- the great portion of spectrum E is contained in the wavelength domain effective in absorption of a camphor quinone of 430-480nm

[0016] Therefore, if such output light is irradiated at photopolymerized type resin, the polymerization of the photopolymerized type resin can fully be carried out by 1/about some dozens optical output of the conventional light source.

[0017] especially -- this example -- the optical plane of incidence of the fiber for condensing -- the light emitting device of Light Emitting Diode chip -- contact -- or it approaches extremely, and since it can arrange, condensing luminous efficacy becomes good and power can also be made high

[0018] (The 2nd example) View 2 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 2nd example of this invention, for 5', an optical irradiation head and 5'a of the incidence opening and 5'b are [the irradiation opening and 6] condenser lenses among drawing, and 1-3 show the same parts as drawing 1 .

[0019] Next, an operation of the light equipment for photopolymerized type resin hardening of drawing 2 is explained. Light Emitting Diode3 has arranged 20 pieces for the domain whose peak emission wavelength is 430-480nm, and the thing whose optical output it is especially 455nm and is 1200microW on the same periphery as well as drawing 1 . these -- an outgoing radiation -- light -- a condenser lens -- six -- condensing -- having -- a condenser lens -- six -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- projecting -- having . optical irradiation head 5' of this example -- abbreviation -- although two or more optical fibers of the same length were bundled and being considered as the briquette by the resin, it is a metal or the hollow pipe of a resin, and you may constitute from the thing and the glass rod itself which carried out aluminum coating so that Light Emitting Diode light might carry out total reflection of the wall

[0020] And the light condensed by optical irradiation head 5' is taken out from the irradiation opening 5'b as outgoing-radiation light through this optical irradiation head 5'. Thus, when the photopolymerized type resin which carried out application restoration irradiates at the affected part, this resin hardens the taken-out outgoing-radiation light.

[0021] In addition, about hardening of the photopolymerized type resin in this example, since it is the same as that of the 1st example, the explanation is omitted.

[0022] (The 3rd example) View 3 is the block diagram showing the outline configuration of the light equipment for photopolymerized type resin hardening which is the 3rd example of this invention, and it is the example using the concave mirror 7 as an output light condensing system of each Light Emitting Diode.

[0023] Also in this example, Light Emitting Diode used the same thing as the 1st and the 2nd example. each -- Light Emitting Diode -- **** -- an outgoing radiation -- light -- a concave mirror -- seven -- reflecting -- having -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening -- five -- ' -- a -- a field -- condensing -- having -- although -- each -- Light Emitting Diode -- three -- an outgoing radiation -- light -- a concave mirror -- seven -- a concave mirror -- seven -- an optical axis -- a top -- parallel -- allotting -- having had -- light -- irradiation -- a head -- five -- ' -- incidence -- the opening moreover, optical irradiation head 5' -- the 2nd example -- the same -- abbreviation -- although two or more optical fibers of the same length were made into the briquette by the resin -- the above -- the same -- a metal or the hollow pipe made from a resin -- or you may constitute from a glass rod etc.

[0024] In addition, about hardening of the photopolymerized type resin in this example, it is the same as that of the 1st example, and an explanation is omitted.

[0025] Especially, at this example, since most outgoing-radiation light wave length uses Light Emitting Diode which is 430-480nm of the absorption wavelength band of a camphor quinone, resin can be stiffened by the minimum luminous intensity. Although generation of heat by the outgoing-radiation light to which it will also pull up the luminous intensity of an unnecessary wavelength band to hardening of resin, and contains such an unnecessary light in it simultaneously although the intensity as the whole light source was enlarged and the luminous intensity of the absorption wavelength band of a camphor quinone was pulled up by it in order to stiffen resin with the halogen light source conventionally caused the cloudy weather of a concave mirror, this trouble is cancelable with this invention.

[0026] By the way, the following examples are also included as an embodiment of this invention.

[0027] (1) In each Light Emitting Diode unit, a condenser lens may be arranged in the front face of Light Emitting Diode chip light emitting device, and the light which emits light from this Light Emitting Diode may be condensed.

[0028] (2) You may condense the light which carried out aluminum coding and which emits light from Light Emitting Diode in the hollow pipe in which a bore becomes small so that Light Emitting Diode light may carry out total reflection of the wall as the irradiation opening is approached instead of using an optical fiber, a condenser lens, etc. as an optical-system means.

[0029] (3) A lens may be put on the irradiation opening of an optical irradiation head, and you may collimate outgoing-radiation light.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER: _____**

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.